URBAN CENTRALITIES: IDENTIFICATION AND RANKING OF FACTORS FOR TRANSPORTATION PLANNING

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ABSTRACT

The inseparable relation between the urban centralities and the transportation system is notorious, which highlights the need for characterizing, identifying and analyzing such centralities in the context of transportation planning. Thus, the present paper aims at applying a method of characterizing and identifying spatial centralities, developed from the use of the Analytic Hierarchy Process, Delphi Method and Spatial Analysis, in two very distinct Brazilian cities: Manaus, in the state of Amazonas and Brasília, the Federal Capital. The results show that the specific characteristics of the urban space interfere in the way the sub-centers of the cities develop and are consolidated; and that the method effectively enables the characterization of the sub centers considering their local specific characteristics and identify them spatially, building a valuable tool for the diagnosis and planning of the city's spatial structure and, consequently, of its transportation system.

Keywords: urban centralities, Analytic Hierarchy Process (AHP), mobility

1. INTRODUCTION

The spatial structure of the city is widely studied and defined in the literature. For some authors the approach begins with the concept of space, considered as a set of fixed structures and flows (Santos, 2000); whereas for others this space is structured by a network of centers and subcenters, or as a set of knots and links (Rodrigues, 2006). Looking at the converging points in those two approaches, it is possible to conclude that the centralities and the system of transportation have an inseparable relation, being paramount to carry out studies in order to identify its elements, evaluate them and propose measures so that the alterations to one of the elements, be both desired and potential to change all the others and vice-versa.

In this context, it is important to highlight that the configuration of the centers and subcenters fosters the development of guidelines regarding the transportation planning, which in turn impact directly people's mobility in the cities. Its identification is essential, for example, to structure the Municipal Directive Plans and the Urban Mobility, directing the planning of actions and the implementation of such policies.

The Ministry of Cities (2004) connects the creation and consolidation of the urban subcenters - multicentralities or policentralities - to the efficiency to the organization of the cities themselves, once through them it is possible to provide the citizens with access to the essential services, avoiding motorized displacements, once it is possible to make short trips on foot or by bicycle; or even favoring the possibility of accessing them by public transportation. It is thus possible to conclude that identifying the urban centralities can contribute heavily to the creation of guidelines for ordering the territory and planning transportation, which favors public means of transport instead of motorized ones, contributing to an improvement in urban mobility in Brazilian cities.

Aware of the importance of the characterization, identification and analysis of the urban centralities in the context of transportation planning, Kneib (2008) developed a method based on expertise. The method uses the Analytic Hierarchy Process (AHP) in order to characterize the Subcenters; and that is followed and complemented by a procedure that seeks to align Spatial Analysis and Delphi, consolidated from the tacit knowledge of experts regarding the urban space they live in. These procedures were applied to two different cities, aiming to create hierarchy of factors that characterize these subcenters and to spatially identify them in the urban grid.

Therefore, the present paper aims to compare the results obtained from the application of this method, which enables i) to compare the hierarchy of factors that characterize the subcenters, obtained from interviews with experts in these two cities; ii) identify them spatially and assign them different degrees of importance. The results show that the specific characteristics of the urban space interfere in the way the sub-centers of the cities develop and are consolidated; and that the method effectively enables the characterization of the subcenters considering their local specific characteristics and identify them spatially, building a valuable tool for the diagnosis and planning of the city's spatial structure and, consequently, of its transportation system.

2. THEORETICAL BACKGROUND

2.1 Urban Centralities for Transportation Planning

In order to describe the relation between the transportation system and the centralities, it is important to start this approach from a broader concept: space. For Santos (2001), space is a concept easy to be understood, however hard to be defined, once it covers a wide range of objects and meanings. In the author's opinion, space can be considered in two ways: as a set of fixed structures and flows; or as a set of object and action systems. In regard to the

first approach, Santos (2004) highlights that the fixed elements allow actions that modify the place itself, whereas new (or renewed) flows recreate environment and social conditions. He considers the flows as a direct or indirect result of the actions that go through or are installed in the fixed, thus modifying its meaning and value, at the same time as they change.

In face of such definitions, this paper is aligned with the concepts developed by Santos (2001, 2004), once it focuses on the human or social space, defined by the author as geographical space. Thus, the concept of space, specially the geographical space, becomes extremely relevant, once it is one of the main theoretical basis of the Science of Geoinformation (Câmara *et al*. 2000), which includes the spatial analysis, used in this paper for identifying the subcenters.

In regards to the concepts and definitions related to space, it is important to highlight that this concept is very wide and that there are several variables and agents which have an impact on it, or are impacted by it. Although we are aware of the range of agents and variables, this paper focuses on the analysis of transportation and its relation to the urban spatial structure, in the context of geographical space. By adapting the concept of Santos (2001) for this paper, we seek to reflect about the relationship between transportation and centralities, as presented in Figures 1 and 2.

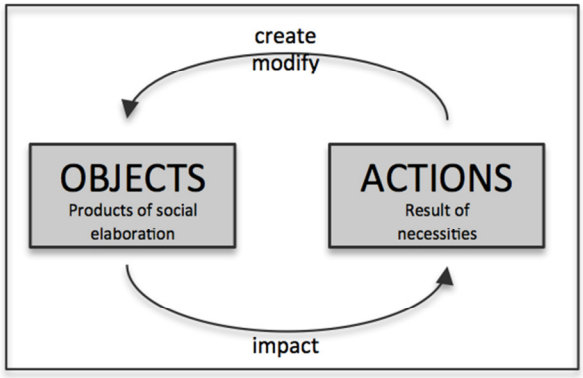

Figure 1: Concept of space in Santos

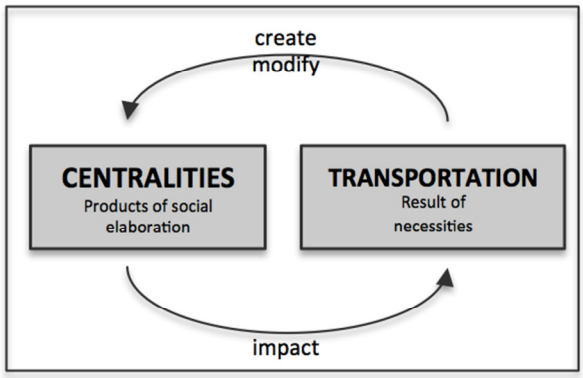

Figure 2: Concept of space applied to this paper

Using one of the afore mentioned concepts of space as a system of systems in the view of Santos (2001), it is possible to associate it to the urban space, given that the transportation would represent one of the kinds of systems of action, once it is the result of a necessity. The system of transportation, under this concept, is both an element that creates the urban spatial structure and is created by it.

In the midst of such discussion, it is important to point out that the main elements of the urban spatial structure are the subcenters, or the centralities. The approach of Villaça (2001), for example, considers as elements of the urban spatial structure the main center of the metropolis (the greatest agglomeration of jobs or of commerce and services); the subcenters of commerce and services (different agglomerations of commerce and services, smaller replicas of the main center), the residential neighborhoods and the industrial areas.

The work of Rodrigues (2006a) certifies that the urban spatial structure is articulated by two fundamental elements: the knots and the link. The links are the infrastructures that support the flows to and from the knots; and define the elements of the urban spatial structure (the links themselves and the knots), confirming, in this approach, an analogy between the knots and the subcenters. The author complements with an approach about the relation between the space, the subcenters and the transportation system. According to Rodrigues (2006b) the purpose of transportation is geographical in nature, once it facilitates movements between different places. Thus, the transportation has a primordial function in the urban organization and spatial structure.

Other authors corroborate the inseparable relation between the subcenters and the transportation system, such as Taaffe *et al.* (1996) and Ferrari (1991), which associate the changes in technology of transportation with the creation of different patterns in the intraurban spatial organization of concentric growth and radial expansion. In summary, in regards to accessibility and transformation of the space, transportation has a direct effect in the spatial form of the urban areas through the impact in accessibility, consequently altering the patterns of land use, one of the main characteristics of the subcenters.

Several authors and papers have tried to describe and analyze the characteristics of the central areas. Based on the work of Kneib (2008), these approaches were grouped according to their main features, which were present in most of the papers analyzed:

- Symbolism, although difficult to measure, is approached by several authors, such as Del Rio (1995), Levebvre (2004) and Castells (1983);
- Accessibility is approached together with the circulation and flows, be it from either the street infrastructure, or the existing public transportation lines viewpoint (Villaça, 2001; Rochefort, 1998; Kneib, 2004, 2008);
- Ratio and concentrations, once the most central areas gather the main commercial activities, services, public and private management, transportation terminals and high rise buildings (Levfebvre, 2004); Castells, 1983; Frúgoli Jr., 2000; Kneib, 2004);
- Land value, which is observed based on the availability of infrastructure, proximity to services, equipment and activities, thus contributing to a higher land value in the central areas, according to Correa (1995), Dantas (1981); Kneib (2004); and Ferrari (1991).

In a recent historical process, the cities have come to hold multiple centers, or nuclei. What it means is that the cities have undergone a process of change in their spatial structure, which was once characterized by the presence of one single center. In this new structure, several centers (or subcenters) coexist, with the same (or different) hierarchical importance.

Several studies about this approach attempt to align the multiple centers city with solutions and better perspectives for the transportation system. Diesendorf (2000), for example, highlights the multiple centralities as one of the characteristics of cities which seek sustainability. According to the author, the policies of incentive to certain modes of transportation must be associated to the distribution of the subcenters: the trips between the center and the subcenters should be done by light rails, buses or bikes; the higher distances for average to high density corridors should be done by light rail or highways; buses and

micro-buses would be used in areas of low to medium low density and suburbs; and the cars should only be used in low density areas, or areas not accessible by public transportation (Diesendorf, 2000; McMillen, 2001).

The relation between the efficiency of the urban spatial structure and the transportation system has been investigated by several studies. According to Schwanwn *et al.* (2001), the studies about multiple centralities are directly related to the issues of displacement patterns, once the efficiency of the urban form directly impacts the time and distance of the commute. As a result, the daily displacement patterns become tangential instead of radial, in most metropolitan areas. This result leads to two distinct displacement behaviors, in the context of multiple centralities:

- According to some studies, the policentrality tends to decrease the time and distance of commuting (Levinson e Kumar, 1994; Gordon e Richardson, 1997; Schwanwn *et al*., 2001, Aguilera e Mignot, 2004; McMillen, 2004; Kneib, 2012);
- According to other authors, individual motorized displacements tend to increase the policentralities, being thus negative (Cevero, 1996; Ewing, 1997). This occurs when the public transportation infrastructure and the incentive to non-motorized means are not aligned to the new centralities (Schwanwn *et al*., 2001; Aguilera and Mignot, 2004).

Therefore, the approaches discussed in this section point out the need to evaluate the characteristics of the subcenters, as well as the importance of their spatial identification, using the methodologies elaborated for that purpose. This fosters a urban spatial structure which contributes, favors and strengthen the transportation system, at the same time it improves urban mobility.

2.2 Tools used in the methodologies

AHP (Analytic Hierarchy Process)

In the present paper, the Analytic Hierarchy Process - AHP is used to rank hierarchically the characteristics of the urban subcenters for planning transportation, as well as making the definitions and characteristics of such subcenters more uniform among experts. This method was developed by Saaty (1991), and it aims at replicating human reasoning in the comparative evaluations of the elements of a set, based on the expert's perception.

AHP is based in three basic tenants: the modeling of hierarchies; the establishment of the priorities and the checking of the consistency of the judgments. The phase of modeling the hierarchies begins with the definition of the hierarchical structure, which consists of and abstraction of the structure of a system to study the functional interactions and their impact on the system as a whole, from gathering the relevant aspects in subgroups. Once the hierarchies are modeled, we then proceed to establishing the priorities, using by the following procedures:

- Pairwise comparisons of the attributes and alternatives;
- Determine the weight of each pairwise comparison;

- Check the consistency;
- Use the weight to obtain a numerical equivalent for different options.

Delphi

In this study, the Delphi is used to identify spatial subcenters, based on the consensus of a group of experts. The method was created to fulfill the need to analyze high complexity issues, based on the opinion and the consensus between the different experts, granting reliability to the result of the method's application (Sáfadi, 2001). The experts themselves are the source of the data (opinions), because they hold the capacity of judgment in order to evaluate the performance of a certain object of study (Marinho, 2006). There is a consensus between the researched authors as to the basic tenants of Delphi: the use of experts; anonymity; the interactive application of several rounds of the questionnaire, giving feedback after each one; and the search for a consensus about the issue at hand.

Spatial Analysis

According to the previous approach, it is important to analyze the relationship between the transportation systems and the subcenters, as they are located in space. Such study is possible through an approach linked to the spatial analysis, as well as tools derived from such analysis. Thus, it is important to highlight that the spatial analysis is the quantitative study of phenomena that can be located in space, and it seeks to evaluate whether the phenomenon studied has a spatial or geographical reference. For Câmara *et al*. (2000), the emphasis of the spatial analysis is to quantify the properties and the relationships of the spatial data which are defined as any data that can be characterized in space in a system of coordinates. Therefore, the main idea of the spatial analysis is to incorporate the space to the analysis one wishes to carry out.

Point Scale

In order to measure the degree of importance of each subcenter - identified through the spatial analysis and the Delphi combined - in relation to the others, a semantic differential rating scale is used, "Osgood's Semantic Differential Scale", (Osgood *et al*., 1964). According to this method, a punctuation matrix is elaborated, which can be 1, 2, 3, 4, 5, 6, 7, where 4 would be origin point; or +3, +2, +1, 0, -1, -2, -3, where the origin is zero. According to the authors, this subdivision in seven items allows us to identify which variables or characteristics tend to have an opposing meaning, from the least to the more important.

3. METHODOLOGY FOR CHARACTERIZING AND IDENTIFYING CENTRALITIESS

The methodology used in this paper to characterize the subcenters, identify them in space and grant them a degree of importance was developed by Kneib (2008). As it can be observed in Figure 3, in order to apply this methodology, the criteria for choosing the experts

must be established, in order to ensure the adequate profiles for carrying out the study. The Analytic Hierarchy Process - AHP is applied to build a hierarchy of the attributes of the subcenters and to enable the experts to assimilate the characteristics used as a concept, using the software Expert Choice, in phase 3..The adapted Delphi method - using GIS (geographic Information System) and Spatial Analysis - is used to identify the subcenters. The last method - the Point Scale - is adopted to grant a degree of importance to the subcenters identified.

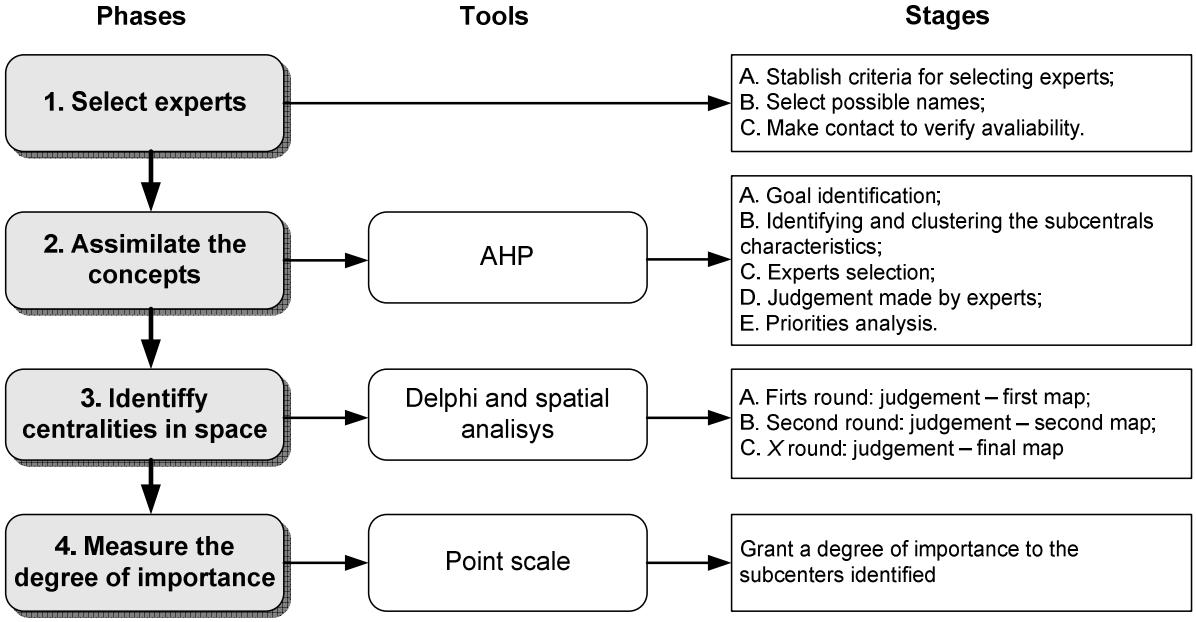

Figure 3 - Subcenters characterization and identification methodology (Kneib, 2008))

This methodology was applied to two Brazilian cities: Brasília and Manaus, the results, analysis and comparisons of which are presented in the following item.

4. METHODOLOGY APPLICATION: CASE STUDY OF MANAUS AND BRASILIA

In order to reach the goal of this work, case studies were carried out in the city of Manaus, the capital of the state of Amazonas and in Brasília, in the Federal District. The choice of these cities is justified because it was necessary to apply the methodology to remarkably different urban environments - as it shall become clear in the items to come - and because of the availability of data and experts, necessary to elaborate the present study.

4.1 The Scenario in Manaus

Manaus, the capital of the state of Amazonas, has a population of 1.802.014 inhabitants and a demographic density of 158,06 inh/km2 (IBGE, 2010). The population growth after 2000 was very accelerated and the transportation infrastructure was not able to follow the same rhythm (City Hall of Manaus and Ceftru, 2006b). Overall, the situation of Manaus is the same

as that of many other big Brazilian metropolis in which the real state crisis directly lead to the efficiency in public transportation.

According to the City Hall of Manaus and Ceftru (2006), in the 80s, the population was concentrated in the center of the city. In the late 1980s and early 1990s, the city's population growth towards the North, East and Northeast was much intensified. The central region, the region of the port and the industrial district had already been consolidated, whereas dozens of new housing developments were built in the North and East regions. By the late 1990s, the North and East regions were consolidated as the highest growth areas of Manaus. From the year 2000 on, the expansion towards the west was intensified, along the Negro River, where the city's middle and upper classes moved to. The schematic illustrations of the land occupation and of the growth drivers mentioned are presented in Figure 4.

A) Beginning 1980´s B) Between 1980´s and 1990´s C) Ending 1990´s

Figure 4 - Occupation and expansion drivers in the city of Manaus

Source: Manaus City hall and Ceftru (2006)

It is important to highlight the following about the transportation system, the fleet and the patterns of movement in the city:

- In regard to the means of transportation of the city, the highest percentage of trips is made by bus – 45.83%, followed by trips on foot (27.86%) and by car (12.01%) (City Hall of Manaus and Ceftru, 2006). The national average with regards to the means of transportation is 21.5% by buss; 27.3% by car and 38,6% walking. Thus, Manaus has a high rate of buss use and a low rate of car use, if compared to the national average.
- Manaus has a fleet of 452,300 vehicles, out of which 252,274 are cars and 83,459 are motorcycles (IBGE, 2010). If those numbers are converted in a rate of motorized vehicles, Manaus presents a 0.25 vehicles/inhabitants rate; or 0.18 individual motorized vehicles (cars and motorcycles) per inhabitant.
- Manaus has more than 240 public transport lines. Currently, the city is served by 10 different public transport companies, which operate the lines with a total fleet of approximately 1600 vehicles, out of which most are buses. Manaus also has 6 integration terminals spread throughout the city, which allow the users of public transportation to exchange buses freely, for a period up to two hours (City Hall of Manaus, 2012).

4.2 The Scenario in Brasilia

The remarkable territorial and population growth the Federal District has been undergoing consolidated its urban area as a polinuclear metropolis. Consequently, it is possible to

observe a metropolitan focus on the planning of land use, new streets, overpasses, parking lots, techniques for placing the city signs and sophisticated mechanisms for electronic control of the circulation, which transform the traffic in an urban 'superfuction' (Government of Federal District, 2004). Today, the federal District is comprised of 29 Administrative Regions, being transportation considered problematic for several reasons, of which the urban structure itself with low residential densities stands out, the most remarkable characteristic of the Pilot Plan Region (Figure 5).

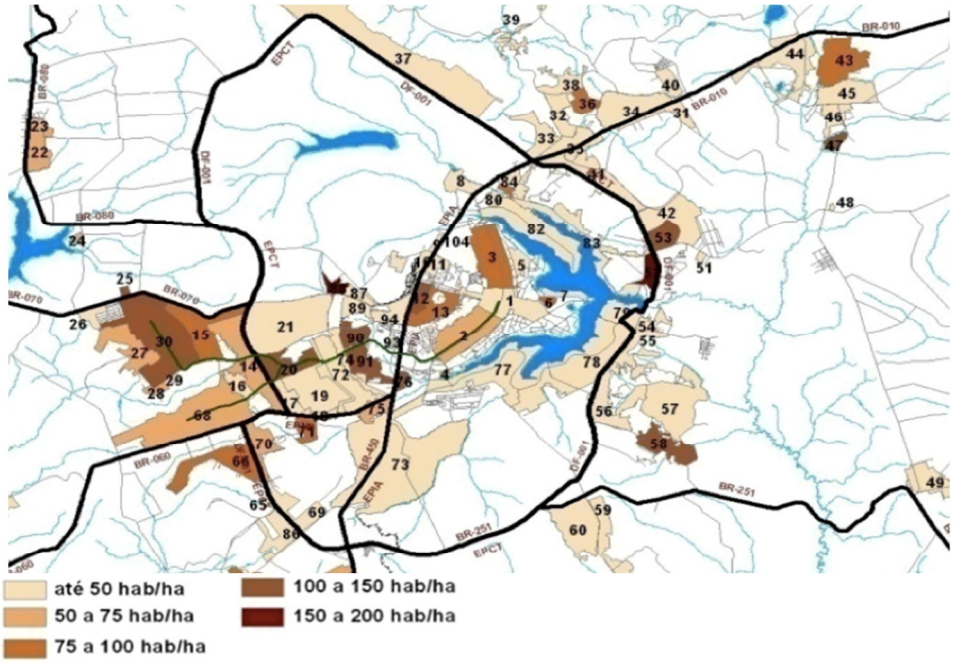

Figure 5 - Federal District Population Density
Source: Government of Federal District (2010)

It is important to highlight the following about the transportation system, the fleet and the patterns of movement in Brasilia and in the Federal District:

- In regard to the means of modal division in transportation, the highest percentage of trips is made by motorized vehicles (77%). Among these, 51% are made by cars, as 41% by public transportation (Government of Federal District, 2010).
- It has a fleet of 1,245,521 vehicles, out of which 924,103 are cars and 124,520 are motorcycles (IBGE, 2010). If those numbers are converted in a rate of motorized vehicles, in Brasilia there are 0.48 vehicles per inhabitant; or a rate of 0.40 individual motorized vehicles (cars and motorcycles) per inhabitant.
- In terms of public transport, there are currently seven companies operating the service in Brasilia, with approximately 2.400 vehicles that serve the conventional routes (buses) and neighborhood routes (micro-buses) (Government of Federal District, 2012). The conventional routes has 800 lines and it connects the satellite cities to the Pilot Plan, whereas the neighborhood routes has approximately 10 lines that serve only the Pilot Plan, connecting the neighborhood to the central areas.

4.3 Application of the AHP to Manaus and Brasília: characterization of the centralities

Based on the bibliographical references that characterize the centralities mentioned in item 2.1, the most relevant characteristics were identified. Later, those clustered and input in the software Expert Choice in order to be evaluated by the experts. The operation in the environment provided by the software Expert Choice starts with the formulation of a problem, after the identification of the crucial elements for the decision making process, fostering the assembly of a hierarchy tree, based on the goals to be reached, the decision making agents, the criteria and the proposed alternatives (Figure 6).

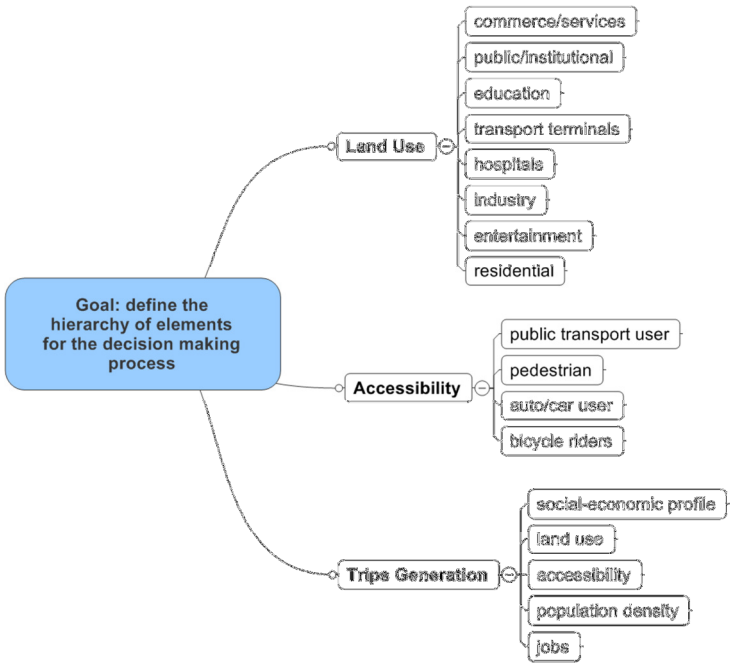

Figure 6 - Hierarchy tree of the relevant elements to the decision making process

The hierarchical structure, as seen in Figure 6, is composed of several levels, integrated by elements. Each element of each level characterizes a node. The highest level of the structure is represented by the node Goal. In a second level, three characteristics were used: land use, accessibility and trips, all elements that arise from the theoretical referential.

Accessibility, understood as the degree to which a certain destination can be easily reached, was detailed according to the agents that perceive it, aiming to enable the analysis of the different scales (micro-accessibility and macro-accessibility), of the pedestrians (micro-accessibility), of the cyclist, of the users of public transportation, and of the car user.

The item Trips was detailed in order to encompass a set of factors: population density, land use, social-economic characteristics, jobs and accessibility. Knowingly, this item includes characteristics of land use and accessibility, pursuant to the approach about trips mentioned before, given that such items are extremely related and the impacts in one affects the others.

As the hierarchy tree is defined, Expert Choice determines the format of the matrices to be employed in the program, according to the interaction of the various levels of the tree structure and in function of the Overall Goal to be reached. The experts fulfill, individually, the results of their judgment in the software itself, once it presents a simple graphic language. Next, the main results are presented, with the values standardized, for each item in the second level, for Manaus and Brasilia. It is important to highlight that, in general, the consistency of the analysis was considered satisfactory, once it was below 0,1.

Land Use

In regard to Land Use, it is worth pointing out (Figure 7) the item commerce/services, followed by public/institutional, as the types of land use that most characterize the areas as urban subcenters for Manaus, pursuant to the goals of this research. For Brasilia, the item public/institutional was considered more relevant for characterizing a centrality, followed by the land of use for commerce/service.

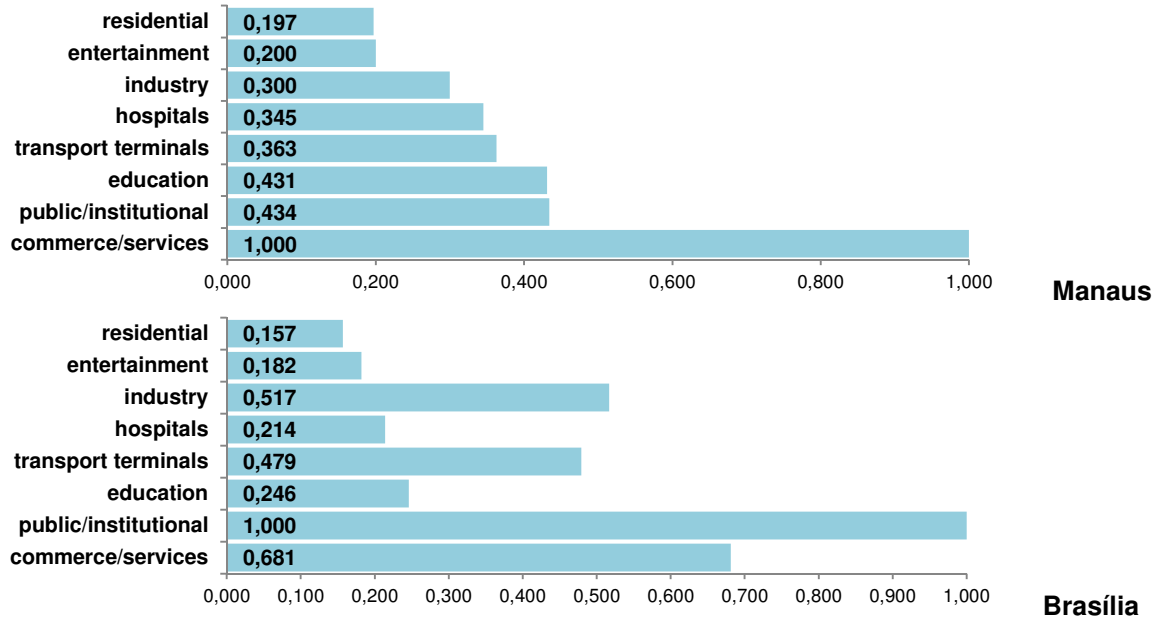

Figure 7 - Hierarchy tree of the relevant elements to the decision making process

Accessibility

According to the scales of perception of the agents, for Manaus the most important was the public transport user, followed by the pedestrian. Among the categories of the public transportation users, which may be used to inform the adoption of policies for consolidating the subcenters, the frequency and number of lines can be highlighted. For the pedestrians, the sidewalks were considered the most important. Such analysis may reveal important preferential indicators for investment in priority infrastructure for each of these agents, which goes against the majority of the policies in place today, that solely benefit the car users (Figure 8).

Similarly to what was detected in Manaus, in the case of Brasilia, the experts interviewed also considered the accessibility of the public transportation users to be the most relevant (Figure 8), being the variable frequency of lines' the one which received the highest punctuation in the evaluations.

This analysis indicated that, in order to foster accessibility to the subcenters, the experts believe that the most adequate solution is to favor the public transport users, with an improvement in the frequency of lines and the conditions under which the buses circle the city. Two possible examples of such improvement in conditions would be the preferential and exclusive corridors, aiming to grant priority to the public transport, thus improving the speed of the vehicles. This approach, however, goes against what has traditionally been adopted in Brasilia, where there has been a growing implementation of infrastructure to serve the individual automobiles, such as the construction of new roads and new parking areas.

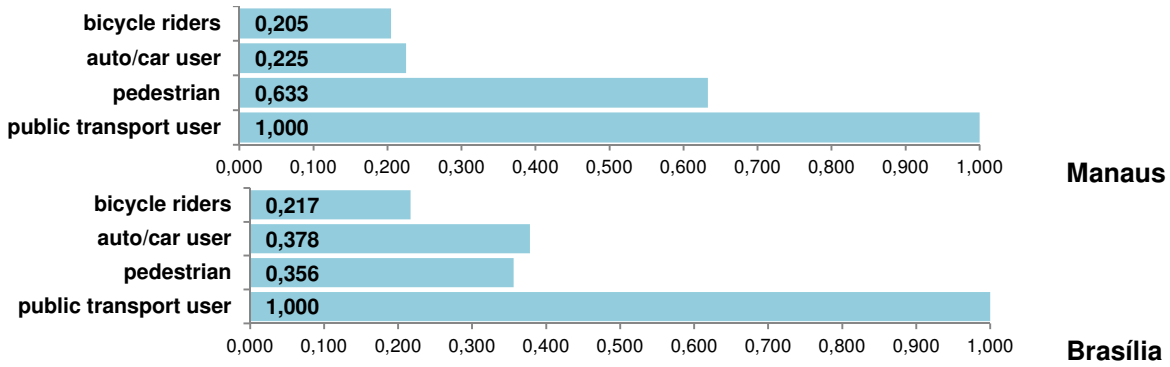

Figure 8 - Standardize values for Accessibility

Trips generation

According to Figure 9, it is possible to observe that, in the case of Manaus, the highest importance was attributed to the social-economic characteristics of the population, followed by the land use, accessibility, population density and jobs. For Brasilia, the population density was considered the most important criteria for characterizing a centrality, followed by the land use, accessibility and the social-economic characteristics.

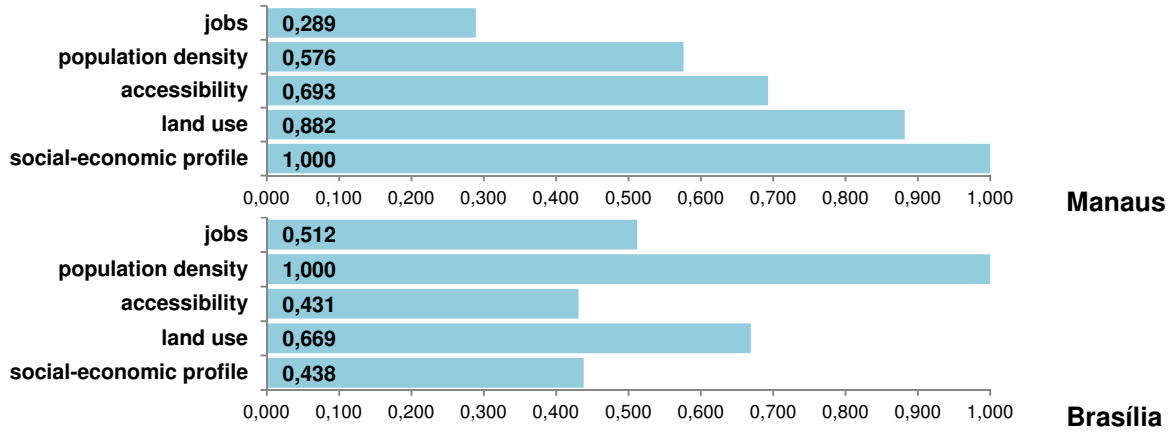

Figure 9 - Standardize values for the item Trips generation

Comparison between Trips vs Accessibility vs Land Use

At last, we present the standardized values for the items in level two, whose analysis shall allow us to reach the goal *Create a hierarchy of the characteristics of the urban subcenters for planning transportation*. Therefore, it is possible to observe that, according to the experts, the main feature of these urban subcenters consist on the trips, both for Manaus and Brasilia. In the case of Manaus, however, the variable Accessibility has proven itself more important that the variable Land Use. For Brasilia, the variable Land Use was highlighted by the experts as more important than Accessibility (Figure 10).

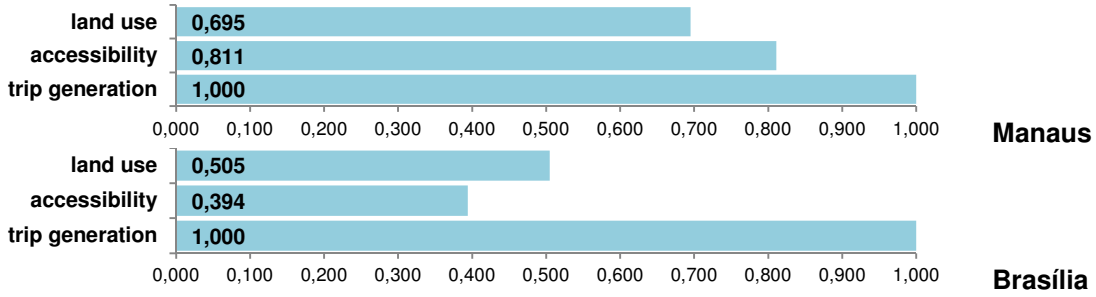

Figure 10 - Standardize values for the Goal

The results corroborate the approach related to the works of Spósito (2001), Kneib (2008), Gordon e Richardson (1996) e Aguilera e Mignot (2004), according to the opinion of the experts. This ratifies the importance of considering the number of trips, a reflex of the social-economic characteristics, land use, population density and the number of jobs in the area. The importance of accessibility to guide the creation of government policies regarding transport infrastructure is highlighted - mainly for public transportation and pedestrians, according to the results of this paper. Such policies could consolidate the subcenters or stop their growth when necessary.

4.4 The application of Delphi to Manaus and Brasilia: spatial identification of the centralities

The third and fourth phases of the method applied encompass the spatial identification and the measuring of the importance degree of the subcenters. After the identification, maps to present the identified subcenters and their degree of importance were made. The degrees of importance were obtained by means of statistics. This application has enabled the spatial identification of the subcenters in this city based on the consensus of a group of specialists, using the association of the three methods earlier described - AHP, Delphi and the Point Scale.

Despite being a historical city, with a remarkable growth during the 20th century, the subcenters identified in Manaus are not all located in the historical center, the Southern region on the map (Zones 101 and 104), as it can be seen in Figure 11 (in this Picture, the numbers correspond to a division in scale of the traffic zone, to make the placement of the subcenters easier). In addition to the center of the city, two other regions stand out: the central area on the map, with the population of highest income and important commercial

areas (shopping malls and stores along Avenida Djalma Batista), and the Northern region, where one of the most important public transportation terminals (border between Zone 503 and 504). In this region, we can highlight the area around the terminal, a very important commercial center. The East and West regions also present relevant subcenters, those being the Industrial District (East) and a touristic region named Ponta Negra (West), respectively. The subcenters identified confirm the hierarchy presented in Figure 7, according to which the most important factor identified in Manaus was the item commerce/services.

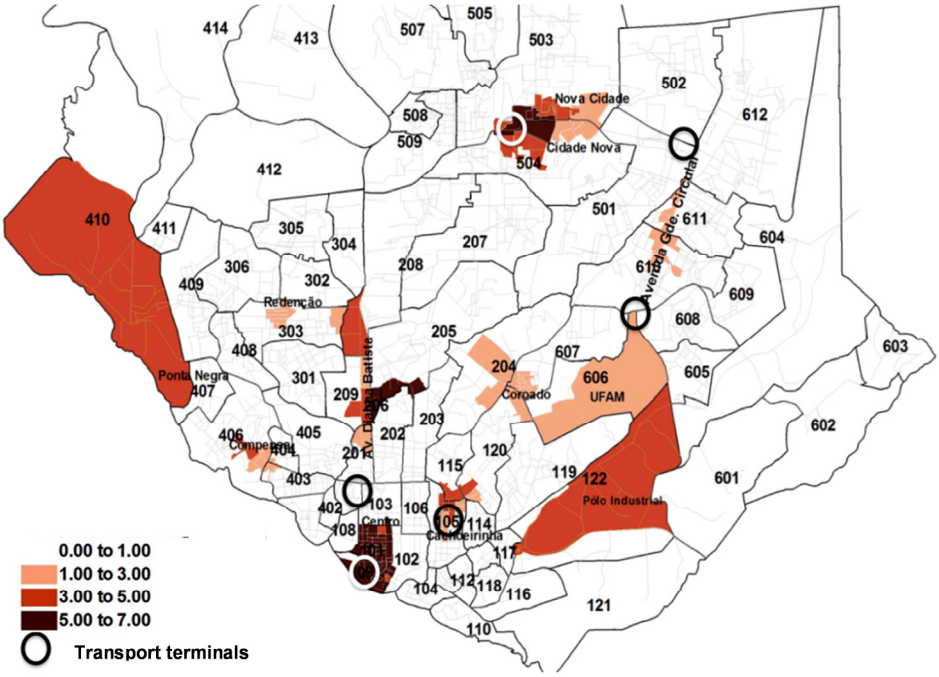

Figure 11- Subcenters identified and their respective degrees of importance -Manaus

Another relevant item is that, in Manaus, the use of transportation terminals is considered a very important activity for its centralities. In Figure 5, it is possible to notice that, out of the 06 terminals of public transportation, 04 are located in areas considered subcenters, thus ratifying the relation between the centralities and the public transport system. This item can indicate the potential of working the displacements between the subcenters by public transport, and even evaluating the possibility of creating new terminals in consolidated or desired subcenters, which may contribute for improving the mobility in the city and strengthening the desired ones.

In the case of Brasilia (Figure 12), the subcenters identifies are more concentrated in the Central region of the city, being either places of clusters of commerce or services, or places where the public institution's buildings are. In this Central region, there is the Pilot Plan bus station, which is an important node with plenty of public transportation available, by both buses and subway, making accessibility to this subcenter easy and contributing to consolidate this centrality.

In Brasilia, among the 25 subcenters identified, only one presents residential use, confirming the results presented in Picture 8, in which the Public/Institutional and Commerce/Services uses were identified as the two main types of land use that determine urban subcenters.

Figure 12 - Subcenters identified and their respective degrees of importance - Brasília

Even having been designed to prioritize movement, Brasilia presents serious problems of mobility, confirmed by the high levels of motorized transport and use of cars, mentioned earlier. In all centralities of the Pilot Plan, the excessive use of motorized vehicles can be verified, which contributes for an increasing demand for parking space, thus degrading the landscape and decreasing the quality of the space for the public transportation users. Therefore, studies and proposals that seek to foster public transportation for longer trips between the subcenter are important. In addition, displacements within the subcenters by non-motorized means must be fostered and encouraged, for being smaller distances that could contribute to reducing the negative externalities associated to the excessive use of automobiles.

5. FINAL CONSIDERATIONS

The present paper attempts to evaluate the results obtained with the application of a method to identify the urban subcenters, applied to two Brazilian cities very different in terms of their urban space. This identification and its analysis seek, amongst other things, to contribute to the planning of urban mobility, as well as support the guidelines related to the territorial arrangement and the planning of transportation that facilitate the way people come and go in urban settlements. It is believed that the results reached can be useful for future researches and projects on the same subject.

The building of a hierarchy of relevant criteria for the configuration of the urban subcenters has allowed an evaluation of the results obtained through the validation of the criteria in relation to the resulting mapped areas. This way it was possible to determine that the main

characteristics of the subcenters are related, in the case of Manaus, to the presence of commerce and services activities, whereas in Brasilia, the presence of public or institutional buildings are more important to confirm a place as an urban subcenters. This difference confirms the results obtained by means of the geographical location of the subcenters, identified by means of interviews with expert users of the city's urban space.

The results obtained can help the decision makers to establish guidelines regarding the territorial organization and the planning of transportation systems in Brazilian cities, especially Manaus and Brasilia, once the centralities have an impact on and are impacted by the transportation system and may be important nodes for the transportation network. Once the subcenters and the most relevant characteristics for a centrality in those cities have been both identified, it is possible, for example to establish guidelines for governmental action. These actions may be in order to foster public transportation connecting the different subcenters and favoring the mobility within the subcenters by implementing an infrastructure that encourages other non-motorized means of transportation, such as bicycle or walking.

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